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ANNUAL REPORT OF THE
CALIFORNIA FOREST AND RANGE EXPERIMENT STATION
1938-1939

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EXPERIMENT STATION

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ANNUAL REPORT OF THE
CALIFORNIA FOREST AND RANGE EXPERIMENT STATION
DIRECTOR'S GENERAL REPORT

INTRODUCTION

The California Forest and Range Experiment Station is charged with the conduct of investigations having to do with the management of wild lands in the region of its responsibility. Under this charge it conducts research looking toward the efficient and profitable management of timber producing lands whether in public or private ownership. It attempts to find basic principles in the handling of forest lands important for watershed purposes. It conducts investigations in proper management of the very large areas of foothill and mountain range lands within California and integration of the utilization of the range resource with other land uses. The over-all program embodies all phases of wild land utilization looking toward obtaining their maximum contribution to human welfare and prosperity.

The program of research has been continuing for a number of years. In recent years, with an increased staff and increased physical facilities, the scope of investigative effort has been greatly broadened. During the emergency period the Station has made a conscious effort to develop physical facilities from a long time point of view, to insure adequacy for many years to come.

The past year has marked the gradual termination of the construction phase in the development of the Station. At most of our work centers the physical facilities are completed and in current use. Their utility in providing adequate quarters for field parties, in supplying a base of operations in representative types, and in providing important centers for the assembly of the interested public has been amply demonstrated.

The region of our interest, extending as it does practically 1,000 miles north and south and 200 miles east and west, has made it imperative for us to develop these centers in order to conduct work efficiently. They have been built during the past few years almost entirely by means of funds and manpower contributed under various

emergency programs. Fortunately, drastic curtailment in emergency funds has coincided for the most part with the completion of important construction projects. This has not been true in all cases, and at two centers we are still inadequately housed. The construction program at the Blacks Mountain Experimental Forest, while nearly adequate to our needs, still calls for two buildings to complete the plant. At the Institute of Forest Genetics, where development necessarily began later than at other branch stations, the construction program is still in progress, and is being carried very largely by WPA.

Perhaps no greater example of the importance of wise and planned coordination with the emergency programs is afforded than the results obtained in rehabilitation of the San Dimas Experimental Forest facilities following the major floods of the spring of 1938. This branch was fully developed and functioning fairly adequately, although there were current continued developments of roads, trails, and necessary facilities. After the tremendous disaster of March 1938, it was possible to utilize regular funds allotted from Washington in comparatively small amounts and very large contributions from WPA to press through a rehabilitation program in three months that brought San Dimas back to at least approximately satisfactory ability to function. It will be years, however, before all damages chargeable to that flood will have been eliminated. It is not an exaggeration to state that rehabilitation of the San Dimas Experimental Forest could not have been accomplished within a reasonable time and the consequent delay would have resulted in the irreparable loss of valuable records had it not been for the close working relationship maintained with the WPA.

As though the major floods were not sufficient to disrupt the smooth functioning of our Influences organization, they were followed in December by a disastrous fire that swept through the most valuable part of the watershed, wiping out numerous experimental plots in our oldest vegetation and destroying many thousands of dollars worth of supplies, material, and structures. This second terrific blow will again be absorbed largely by the use of whatever allotments of regular funds become available and further large contributions from relief programs.

The overwhelming floods of 1938 in southern California pointed again to the enormous importance of our program of research in watershed management, streamflow, and erosion control in the chaparral forests. The stimulation to the flood control program given by these untoward events was reflected in the immediate authorization of final surveys on the three major watersheds of southern California. This required the immediate staffing and rushing into the field of a well-organized survey crew. It was necessary to draw heavily upon Influences personnel already trained, and this contribution naturally further

embarrassed the regular program in Influences research. The drain of the flood and the fire and of the flood control program upon the time and energy of the supervisory staff has of course been very great.

In spite of the difficulties in the Influences division it has been possible to push forward on all other fronts in a satisfactory manner. The drastic curtailment of CCC funds during 1938 was absorbed with a minimum derangement of current programs. It was inescapable, of course, that some lines of work should be curtailed. The necessary readjustments in program again have taken heavy toll of time and energy of the technical staff. Inevitably the tendency is to try to keep going lines of work that have been started and, when the curtailment comes to keep them going in spite of inadequate manpower. The necessary adjustments have been made, and work in all divisions is moving forward from a stable basis.

Forestry problems in California are so definitely interrelated that the Station's continued policy of correlation of effort in all fields is paying dividends. The current activity and the beginning of actual construction of the facilities connected with the great Central Valley Water Project bring into focus more clearly than ever before the absolute necessity of adequate management of our wild lands in order to preserve the possibilities of the vastly important agricultural irrigation enterprise of the State. All divisions are closely interwoven in their efforts toward this major objective. Fire, Range, Survey, Economics, and Influences have direct and intimate connection with the water problems of this State.

It has been exceedingly gratifying to find the Station in the forefront of public work designed to study and integrate the water and flood problems of the region. This has come about because we are well equipped both in technical personnel and physical facilities to engage in such studies. In the work of the National Resources Committee and of the various other public agencies that have dealt and are dealing with these complicated problems, the Station's voice has been heard with authority, and great values have been obtained both in actual results and in improved public relationships. Of great importance have been the fine cooperative relationships maintained throughout the conduct of this work with other Federal agencies engaged in the field. This cooperation has not just occurred; it has been fostered and developed by actual intent.

During the past year our work in Forest Management in the pine region has made conspicuous progress, especially in the conduct of operations at the Blacks Mountain Experimental Forest. For the first time we were able to bring together a representative group of interested lumbermen to demonstrate to them the basic principles involved in our logging and investigative efforts at Blacks Mountain, and to discuss

with them freely and frankly the long-range problems in the management of our important pine resources. We believe enormous values will be derived from such meetings in the future, both from our standpoint and from the standpoint of the lumber industry. In keeping with policies that have proved successful in other divisions, we have invited the lumbermen to appoint an advisory committee to cooperate with us in the formulation of programs, evaluation of results, and critical review of our Blacks Mountain enterprise.

The condensed reports of the various divisions are given below under appropriate headings.

FOREST MANAGEMENT RESEARCH

Pine Region

Introduction

Forest Management research in the pine region is now beginning to repay the benefits of experimental work begun over 25 years ago. In the nature of tree growth, only observations that have been carried on for a long time can lead to true conclusions as to the actual happenings within a timber stand. Many of our experimental plots that were cut over 25 years ago now begin to tell a full story of the results of various cutting practices and stand improvement methods that have been involved. The services of the division devoted to research in pine management have been of great importance in the past to the national forest administration within the region and to the development of improved forest practices within the very large holdings of private timber operators. There is no question but that enormous improvements in land management for the production of pine timber have been obtained in recent years. The over-all objective of research in pine management is to develop methods of harvesting timber crops that will insure optimum growth within the residual stand, proper stocking, and adequate regeneration so that timber holdings can be operated on a sustained yield basis.

The Blacks Mountain Experiment in Sustained Yield Management

Major progress was made in the sustained-yield project at the Blacks Mountain Experimental Forest. Boundary monumenting was completed for the Experimental Forest, and the road system and various other improvements were brought nearly to completion. With the obtaining of additional trucks, our log-hauling capacity was increased. The late spring prevented the beginning of operations until June 28, and because of various interfering factors such as fire, the total cut delivered to the purchaser was only 1,635 M B.M. Although this volume

is far below the scale of cutting we must reach if the various operations are to be conducted at the rate necessary for the accomplishment of salvage insect control and subsequent silvicultural cuttings, we are sanguine of the possibility of reaching such a scale. Preliminary salvage insect-control cutting was completed on only 293 acres. The first block of four plots for detailed methods-of-cutting study was established. It is proposed to repeat the establishment of the blocks in a randomized manner for a number of years.

The principal obstacle to satisfactory capacity operation on this project continues to be the necessity of a long truck haul to the Fruit Growers Supply Company railroad. We are continuing pressure to obtain equitable rates from the Western Pacific Railroad Company. When this is accomplished, the much shorter truck haul will easily enable the stepping-up of our cut to the necessary scale for proper conduct of the experiment.

In addition to the meeting of pine lumbermen referred to in the introduction, a group of forest entomologists from the Bureau of Entomology and Plant Quarantine met at Blacks Mountain in July to discuss insect-control phases of the project. The Forest Management group from the Region 5 training school visited the Experimental Forest in October. In general, this project is attracting a great deal of attention from practical and scientific men.

Growth in Selection Stands

The work on growth in selection stands continues to center largely on preparing for publication the results of more than 25 years of work. It is confidently expected that this manuscript will be submitted during the coming year. A noteworthy contribution in this field was the publication of the paper "Sampling error in timber surveys." This paper grew out of the 100 percent cruise of the Blacks Mountain Experimental Forest, which will undoubtedly prove to be a mine of similar useful publications in the near future.

A considerable amount of effort has been necessarily put upon the revision of administrative practices, in cooperation with the Timber Management Division of Region 5. The Station has taken the position, based on its long experience, that "post-mortem" sampling through growth studies with the increment borer, mortality surveys, tree classifications based on increment borers, and tree values reconstructed from log values has resulted in grave basic errors in new administrative practices.

The application by Region 5 of a new lighter-cutting policy on selection areas brought about the participation of the Division in sample marking with the Regional Division of Timber Management. The

modified cutting method, which includes a subclass of Region 5, tree class 5, called class 5 A, is designed to promote selection of the best trees for the heavier reserves and was included as one of the treatments in the methods-of-cutting studies initiated at Blacks Mountain. On September 17 administrative officers from Washington and from Region 5 reviewed material from the methods-of-cutting studies at a conference. The results of this 28-year-old study suggest cutting treatment considerably at variance with new practices being put into effect.

Planting Research

Planting research in the northern California brushfields has made some progress during the past season, with the following results: Various methods of brush treatment - burning, stripping, and combined burning and stripping - did not differ significantly in their direct effects on seed-spot or transplant survival. Stratified seed sown in the spring in screened seed spots gave second-season survival almost as high as survival of transplants - 80 percent as compared with 86 percent. Seed-spot survival has been highest where brush has been stripped only.

Basic Silvicultural Research-site Factors

Silvicultural research was limited to maintenance of seasonal records in a program estimated to require 5 to 10 growing seasons for representative samples. The almost entire absence of a seed crop permitted very few observations in seed production. There was practically no current establishment of reproduction.

Need for Second-growth Research

Probably the most important pressing need in Pine Management Research is the institution of an adequate program in management of second-growth lands. The primary requisite for the initiation of such a program will be the acquisition for research purposes of a suitable block of representative second-growth timber.

FOREST MANAGEMENT RESEARCH

Redwood Region

Introduction

Forest management research in the redwood region offers many problems distinct from those within the pine region. Clear cutting and burning have steadily reduced the redwood forest area. Destructive logging practices and a lumber market that absorbs only high quality specialty wood have left tremendous quantities of wood lying on the ground. Burning in conjunction with logging operations has been very destructive of natural reproduction and has left most logged over areas in an unproductive condition.

As heretofore, research in the redwood type is badly hampered by the absolute lack of control of plots and sites for research work. Until the establishment of national forests in the redwood region permits the necessary type of control through the withdrawal of a research forest, it will be necessary to concentrate our limited resources principally upon short-term studies of immediate value. Such studies contribute to current efforts to interest private operators in better management practices. Considerable progress has been made toward completion of scheduled work on logging methods and costs, slash disposal, redwood volume tables, and an estimate of the condition of redwood cut-over lands.

Logging and Reproduction

Reexamination and remapping of reproduction quadrats following the controlled logging in the Henry Creek area were completed in the fall of 1938. The area continues to show up well, with an average of nearly 90 percent stocking for all sized seedlings, most of which have lived through three growing seasons. It is plain that by taking proper measures in logging and by leaving a proper reserve stand, restocking from natural seeding can be obtained and is a much more reliable method of reforestation than clear cutting and planting.

Mensuration

Measurements have been taken of 700 redwood trees, largely in connection with logging studies, to form a basis for the preparation of a satisfactory and usable volume table. During 1939 about 150 more trees representing a wide range of conditions will be selected and measured, and these subsequent measurements will be used to check the reliability of the preliminary table.

Slash Disposal

Slash disposal is one of the most important problems in forest management in the redwood region. It is extremely complex and must be attacked on a wide front with adequate control and facilities. With the limited men available, work has been limited to the development of less destructive burning practices. Considerable experimental progress has been made and the results have been of great interest to operators. However, no additional field work can be accomplished until more adequate facilities are available. It should be emphasized that any program of slash disposal would be greatly facilitated by effective utilization of bark and wood now left on the ground.

FOREST MANAGEMENT RESEARCH

Forest Fire Protection

Introduction

The importance of forest fire control in the management problems of California forests is too well known to require amplifying. The complexities of the problems involved in research designed to improve forest protection result from extreme difference of cover types, a great variation in climate, and generally extremely wide variability in terrain. It was early recognized that adequate fire protection in this region could not be obtained without the laying of a firm foundation in factual studies, closely correlated with all phases of fire protection management. As a result close cooperation between the Administrative Branch and the Branch of Research has been the rule, in both the conduct and the application of research.

Four main fields of fire protection research are recognized:

- Behavior
- Effects
- Economics
- Control

At present behavior and control, particularly, are under investigation at this station. Fire behavior research, including investigations covering forest fire ignition and spread, is the basis for the development of successful fire control practice. Studies in the field of forest fire control are designed to provide practical and timely solutions of immediate fire control problems.

On a basis of technics in detection, transportation, and communication plans, all phases of forest fire protection on the national

forests of the region were revised during the period 1933-36. Research in behavior was undertaken for the first time in 1933. During the ensuing years several fundamental problems in fire research have been defined; subsequent research has, therefore, been concentrated on the study of the measurement of basic factors in rate of spread, fuel moisture, and wind velocity. In addition to these, rate of spread has been studied in the field by the use of test fires in the brush types of the Shasta Experimental Forest.

Fire Behavior

Fire behavior studies are necessary in order to forecast fire danger, to permit determination of size of crew and speed of attack requirements, and to promote development of fire suppression tactics and strategies. Current work in the study of fuels has for its objective the recognition and measurements of those characteristics of forest fuel that have a very important influence on the rate of spread of fire. The answer to this problem is essential to the prediction of the influence of wind, fuel moisture and slope in various fuel types, and to the determination of criteria to employ in the connection of fuel type in fuel type mapping.

Information gained in laboratories and field studies and the arrangement of the fuel indicates that the state of subdivision as expressed by $\frac{V}{S}$, in which V equals volume of air spaces or voids and S equals surface area per unit weight of fuel, is an important fuel characteristic influencing the rate of spread of fires, principally under a wind velocity of zero. The most urgent problem for future determination is the importance of these influences under favoring wind conditions. During the next field season, observations will be made in the recently completed 6-foot wind tunnel to aid in answering this question.

Fuel Moisture

Since a standard method for determining fuel moisture in litter samples has been developed, the way is clear for the study of quantitative relationships between fuel moisture and weather elements. The results of this work in conjunction with measurements taken by moisture-indicator sticks in field practice will provide a basis for predicting from current weather conditions the probable fuel moisture.

Fire Danger Rating

Fire danger rating for California national forests was attempted in 1937 by a coordinate committee of Regional Office and Forest Experiment Station personnel. The project has drawn heavily upon plans

developed in the project in forest fire behavior, as well as upon the experiments of other regions and experiment stations. In 1937 a method was devised and put into practice in four national forests. After the result of this work had been carefully analyzed, at the end of the season, the system was revised. During 1938 the revised system was put into effect on eight additional forests. The revised system differs from other systems principally in the recognition of two main phases of fire danger in ignition and spread and in the method of integration of fire danger measurements into class of organization rating. In the California system, rates are made on the basis of areas delineated by climatic and cover characteristics. During 1939 the methods will be further revised and will be extended to the remaining forests of the region.

Much should be said of the valuable cooperative work being conducted by the United States Weather Bureau, especially with regard to the inception of lightning fires.

Firebreak Maintenance

The work on the maintenance of firebreaks by the use of chemicals, which has been in progress for several years, has reached the stage of demonstration and extension. During the past year work on the project has been largely in this field. For administrative purposes over 30 miles of 5-foot backfire strips were treated on three southern and three northern California national forests. Treatment was greatly expedited by the development of a machine for the application of white arsenic. Demonstrations were also made in the use of white arsenic for fire-proofing roads, camps, and groves and for maintaining rights-of-way along power lines.

Resistance to Control

Further work was accomplished on studies of resistance to control, in cooperation with Forest Supervisors of Region 5. The results of over 200 tests have been received and partially analyzed. During the year a new type of brush saw, developed by this station, was prepared and tested successfully in southern California. Further development and tests of the fire-line motor saw are planned.

Fire Statistics

A satisfactory beginning was made in the execution of a plan for analyzing forest fire statistics in the southern California sub-region. The analysis of records should be completed during the present year. The primary objective of the study is the preparation of a usable guide to the development of a research program in the southern California subregion.

FOREST MANAGEMENT RESEARCH

Forest Genetics

Introduction

It has long been recognized that the techniques of genetics so successful in developing superior field crops, offered similar promise in the production of improved strains or species of forest trees. Obviously any program looking toward this end must of necessity be a long time program since the growth of trees is slow. Due to the far-sightedness of Mr. James G. Eddy, the Eddy Tree Breeding Institute was founded in 1925. In 1935 Mr. Eddy turned the then well developed Institute over to the Forest Service, it was rechristened the Institute of Forest Genetics, and under Congressional grant operations were begun in the new status.

The past three years have been rather largely occupied with the development of improved physical facilities and the filling of the various staff positions necessary for the full realization of the program.

The early work of the Institute dealt largely with the segregation of superior strains of ponderosa pine through the testing in actual growth of seedlings from known parent trees. The program has been elaborated and rounded out as will appear below.

With the filling of the complement of technical personnel at the Institute of Forest Genetics, attention has been given to planning and coordinating a long-range program of research. We are now staffed adequately to carry on the work in progeny testing, breeding, physiology, cytology, and taxonomy, that is necessary to give us a well-balanced program. It is becoming evident that the various lines of endeavor supplement each other very well indeed. As time goes on a better balance undoubtedly will be attained between the various branches. In the past the work in progeny testing has perhaps been overemphasized because of the lack of technical personnel in other important fields. It is now felt that, although progeny testing will remain a very important part of the Institute's program, it will be better implemented and much more critically reviewed because of the addition of well-trained men in other branches.

The work in breeding, the production of carefully controlled crosses, back-crosses, etc., depends upon cyto-taxonomy for the final careful check of results. The cytologist can give excellent guidance in the technique of crossing, and in the long run he can be of great service in all phases of the breeding program. The physiological

approach must be used in much work aiming at the stabilization of hybrids by artificial means and in certain specialized fields integrated with the general genetics program. These are random examples of the manner in which the technical branches are integrating their efforts. Perhaps the greatest values are obtained in the continual internal criticism from men who represent varied points of view.

Progeny Tests

The present large progeny test that was started in 1937 has now come to the stage in which progeny will be selected for the arboretum phase of the experiment. Every effort has been made within the past year to contain the necessary statistical operations within the Station's staff. It is believed that these efforts have been successful and that in the future we shall derive a great deal of value from having achieved independence along this line. It is determined that when the present progeny test is safely out of the seedbed stage no further progeny tests will be initiated until all results of past tests have been completely analyzed and reported. Further, it is determined that there will be no more progeny tests on the present large scale. It will, at some time in the future, be necessary to repeat small progeny tests on selected parents included within the present one, in order to satisfy ourselves that duplicable results can be obtained in the seedbed.

Breeding

Significant progress was made in the breeding program during 1938. This program is aimed at the production of new hybrids and offspring from various types of controlled pollinations. During the season 18 new crosses were made, but of course it will be some time before the measure of success obtained will be known. Seed from several 1937 crosses will be sowed in 1939. With the aid of new physiological techniques we are very hopeful that some successes will crown our efforts to stabilize species hybrids within the pines.

Physiology

The new physiological work has resulted in successful vegetative propagation by rooting of Pinus radiata, P. ponderosa, P. strobus, P. canariensis, and P. sabiniana. Considerable work has been done in attempts to induce polyploidy in vegetative tissues, but no conclusions can be drawn until cytological analysis is completed.

A satisfactory method of detecting growth hormone in pine shoots has been found. This is expected to form the basis for a possible physiological selection of superior seed trees.

An interesting and significant development is the apparent correlation of phosphorus content of elevational strains of ponderosa pine with the phosphorus content of the soils in the various elevations which became evident when these seedlings were grown from seed in natural soil at Berkeley.

RANGE RESEARCH

Introduction

The responsibility for range investigations is a divided one. National forest lands comprise mostly higher mountain and mountain meadow range lands which are an important link in the economic chain of range management in the region. Investigations in any one phase of land management devoted to range can only be incomplete unless integrated with investigations in other phases. Because of this situation the range research program at the California Station is closely integrated with the work of other agencies, especially that of the Animal Husbandry Division of the College of Agriculture of the University of California.

The demands for range research continue to exceed by far our ability to meet them. We have centered our efforts thus far on cattle management in the Sierra foothills and on cattle management in the eastside pine range country. In neither field are we adequately staffed to meet pressing problems. It has not been possible to undertake any research thus far in the field of sheep management, in which the pressing problems are as numerous as or more numerous than in the field of cattle management. There is no doubt that very large results could be obtained by the establishment of an experimental sheep station somewhere in the north end of the Sacramento Valley. These results would not only be broadly applicable in improved management methods for the range lands involved, but would go far toward reducing the pressure for mistaken methods of brushland clearing in this critical area.

At the San Joaquin Experimental Range, increasing returns in public relations have been obtained. The cooperative program, which has united the efforts of the University of California, the Regional Office, the Biological Survey, and the Station, has functioned with a uniform degree of success. The program could never have been carried on without some such set-up.

Ecological Relationships

Significant changes in the composition of feed on the San Joaquin Range occurred during the present year. Introduced species made up only 44 percent of the feed as compared with 76 percent in 1937. The

decrease is apparently accounted for by late fall rains, which favored germination and growth of the native annuals. Comparisons of annual forage crops continue to show the extreme variability of the amount and composition of the crop and its relationship to rainfall and temperatures. It is this extreme variability which management must learn to combat successfully.

Significant data were obtained on the relation of degree of grazing to weights of animals at the end of the grazing season. It is becoming more and more clear that too close grazing does not pay.

It has also been determined that the degree of use has a great deal to do with the production of feed during the subsequent year. In general, it pays dividends to leave some old feed on the ground to serve as protection for the next year's crop.

New Range Plants

In our testing of new range plants, we have found no hope so far that summer growing grasses can do well in the prevailing climate of the foothills. The native perennial grasses dry early in the season and are mostly dormant throughout the dry summer season. None of the perennial grasses thus far introduced show any marked tendency toward becoming dormant during the summer. There is some hope that subterranean clover (Trifolium subterranean) may prove to be a valuable plant for introduction. Several of the burclover species tested have also done well in the forage nursery. The indications are that we shall have to give consideration to possibilities from late-spring planting.

Animal Husbandry - Foothill Range

The first cattle sold from the San Joaquin Range were sold last summer as long two-year-olds. The group that had been fed supplementally for two summer periods and again for 49 days just previous to marketing averaged 1,141 pounds. The group that had not had any supplementary feeding averaged 910 pounds. The cattle fed supplementally were sold at \$8.75 per cwt. and the others at \$7.50, which gave a difference of \$31.59 per head in favor of the cattle fed supplementally. The feeding cost was \$21.90 per head, making a net difference of \$9.69 as a result of supplemental feeding.

It may be interesting to note that this group of steers given supplemental feeding topped the San Francisco market, and in a second sale later in the season of younger supplemented steers from supplemented cows we again topped the San Francisco market. The finishing of two-year-old and long-yearling beef by means of supplemental feeding on this

type of range constitutes an encouraging start on the problem of maximum utilization of range in producing beef to meet present market demands.

Quail Management

The cooperative study in quail management continued with the Regional Office, the Division of Zoology of the University of California, and the Biological Survey. In addition to the food-habits studies, a controlled quail-hunting experiment was initiated. A tract of 720 acres was set aside as a hunting area, and another area of 720 acres was used as a population-check area. It was proposed to remove about 25 percent of the birds on the shooting area, in order to determine the effect of this cropping rate. Hunters were chosen from local sporting organizations by lot. A total of 136 quail out of 513 were taken, 26.5 percent of the original stock. An additional 57 birds reported as non-recoverable cripples brought the total loss up to 37.6 percent. It is proposed to reexamine the quail population at various intervals in order to determine the rate of recovery from this degree of hunting.

Grazing and Pine Reproduction

The results of our efforts to answer the question of the effect of cattle on pine reproduction in the eastside pine region have led definitely to the belief that cattle cause very little damage to reproduction. Unfortunately, the studies thus far are open to the criticism that the number of seedlings involved has not been enough for satisfactory experimentation.

The present policy of excluding sheep from cut-over lands in some eastside forests has led to considerable pressure to obtain answers to the same problem in connection with sheep grazing. Some information on sheep was obtained during the last year in the Lassen, Plumas, and Modoc National Forests. The data, while fragmentary, uphold the general observation that sheep do not graze widely on stands of established reproduction. The exclusion of sheep from cut-over lands on which there are satisfactory stands of established reproduction hardly seems justified on the basis of observations to date. There is nothing definite to indicate that sheep are any more harmful than cattle to reproduction.

The effect on seedlings is not so clear. Considerable effort should be spent in the future on the seedling phase of the grazing-reproduction problem, especially in connection with sheep grazing.

Animal Husbandry - Pine Range

In 1937, steers grazed on the Burgess Spring Experimental Range,

a pine cut-over range, showed phenomenal weight increases. During 1938 the stocking was maintained at a rate of 18 acres per head, compared with approximately 35 acres in the preceding 2 years. In spite of the increased utilization pressure, the average daily gain per steer was 1.4 pounds, somewhat less than in 1936, or 1937, but still enough to indicate clearly the high forage value of the cut-over timber type. It is hoped that the work in the pine cut-over type can be continued for a sufficient number of years to enable us to follow grazing values during the period of restocking with pine regeneration.

FOREST PRODUCTS

Introduction

The work of the Division of Forest Products has in the past been largely confined to working out the economics of lumber production and its integration with management practices. The most efficient tool thus far utilized has been the logging and milling study in which tree values have been accurately derived from thoroughgoing cost studies. Very large improvements in forest practices have been obtained through the setting up of minimum profitable diameter cutting limits. The Division has also, in recent years, exercised an important function as an advisory agent to wood utilization industries within the region of its responsibility.

It is confidently expected that with the reorganization of the work of the Division, made necessary by certain shifts in personnel, a profitable reorientation will be obtained along somewhat different lines. Among other plans it is thought that the work of the division may profitably be directed toward increasing the consumption of lower grade materials from species now harvested within the region itself. Further efforts will probably be made to enhance the local consumption of those species that now constitute management problems, for example, white fir, incense cedar and Douglas fir. There are certain obvious necessities in improved milling techniques that may take advantage of the rapid development of tractor and truck logging and provide harvesting practices capable of more intensive utilization of the material that must be removed from the forest in order to provide good management.

As in the past, the demands for work by the Division of Products have far exceeded the capacity of the limited personnel to execute. In spite of this fact, satisfactory progress was made along several lines.

Log Grading

The new log grading system, developed since 1929, and used by

the station in economic analysis of timber on all Blacks Mountain operations, has proved its value for such research work. The forthcoming report on log grading will derive its material mainly from three studies: The Stanislaus studies of 1929, the Meadow Valley studies of 1937-1938, and the Fruit Growers Supply Company studies of 1934-1937. The last includes 201 logs taken from Blacks Mountain.

Logging and Milling Studies

The Meadow Valley mill study was undertaken in 1937 to meet the needs of the Regional Division of Timber Management for data on stands of sites 2 and 3 in the Feather River district. The computing work on this study is nearly completed and final analysis of lumber grades and values by species, log grade, and diameter should be completed before the beginning of the 1939 fall season.

As a check on log grades at Blacks Mountain, and to further evaluate data on Blacks Mountain timber, a lumber production and degrade study was begun in the Fruit Growers Supply Company mill in 1937. Analysis was made of combined green lumber production, seasoning, surfacing, and degrade of 201 logs from the Blacks Mountain Experimental Forest, and 36 rough logs from the Fruit Growers Supply Company timber sale area.

Part I, "Field procedure" of "Field and office procedures adapted to logging and milling studies in the California pine region" was issued in December 1935. Due to various complications that arose in connection with analytical methods, Part II of the manual covering office procedure, has not yet been issued. The new manuscript is expected to appear during the current year.

This station has stressed determination of changes in lumber value that accompany handling, drying and surfacing operations. The results show conclusively differences that are too important to be ignored, and that the practice of discounting green lumber values on a flat line basis in general gives unreliable results. Data on this subject have been well developed and an analysis will be complete in the near future.

Logging Methods

In view of the fact that in pine logging, tree length yarding with tractor-arch equipment is rapidly being adopted in the pine region, a study of this system was necessary in order to translate Blacks Mountain costs to costs under standard logging practices. A short tree length logging study was, therefore, made in October 1938 on the Fruit Growers Supply Company operating area. While it is obvious that the limited sample obtained during observations covering only twelve

days cannot be adequate, it will be of considerable value in connection with Blacks Mountain cost predictions for private operations.

"Blacks Mountain" Cutting System

The Products Division, utilizing newly developed logging grades, has taken part in the work on the Blacks Mountain Experimental Forest, especially in evaluating the three different cutting systems installed on that operation. Some questionable assumptions had to be made in connection with probable costs on logging under silvicultural selection and modified Forest Service systems as done by private operators, and some in connection with the value of the timber to be taken during the second cutting phase of the silvicultural selection system. If these assumptions are valid, the combined phases of the silvicultural selection system would apparently yield better returns than the Forest Service or modified Forest Service systems of cutting in the first cycle.

Products conducted rather intensive cost accounting on the Blacks Mountain operation with a view to translating labor and operating costs into terms of private operation. With the installation of a satisfactory system an accomplished fact, and recent curtailment in Products personnel, this work cannot be conducted under this Division.

Future policies in connection with the work of the Products Division cannot be well determined at this time. It is clear that heavy obligations rest upon Products work in the execution of the Blacks Mountain Experimental logging operation, which must be carried.

It is also clear that a reorientation of the work of the Division is possible along several other lines. It is expected that a definite choice of program and development of satisfactory organization will be accomplished during 1939.

FOREST SURVEY

Introduction

The Forest Survey project in California has never been sufficiently well equipped with funds to engage in extensive inventory work. With the limited facilities available, it has seemed most desirable to engage in procedures basic to the general problems of land utilization and to lay a satisfactory basis for future inventory work. The project's resources, therefore, have been very largely turned to the preparation of vegetation type maps and certain attendant values derivable from them.

In general, the work has been grouped under the following headings:

1. Vegetation survey and type map.
2. Forest resources map.
3. Land utilization studies.
4. Timber volume inventory.
5. Ecological studies.
6. Herbarium.

Herbarium

The herbarium has served as a very important adjunct to the vegetation type map and has been working in cooperation with the University of California, very largely with WPA help. Its value in the training of field-mapping crews, by furnishing reference material of known source, has been very large. As a result, also, of the extraordinarily fine collections of type material over wide ranges, the preparation of field keys in difficult plant groups has been facilitated. The herbarium now contains a collection of more than 25,000 specimens and is being widely used by botanists and ecologists. It is proposed during the coming year to prepare field keys and charts for as many of the following genera as possible: Arctostaphylos, Salix, Artemisia, Chrysothamnus. It is proposed also to build up a separate seed collection herbarium.

Vegetation Type Map

In the vegetation type map project, which continues to fill many needs in many phases of land-use studies and management problems, the present status is represented by the following tabulation:

	<u>Acres</u>	<u>Percent</u>
Total area of project	72,100,000	100.00
Field mapping completed	32,006,000	44.39
Field mapping completed but unchecked	6,931,000	9.61
Office work completed	23,060,000	31.98
Quadrangles published (18)	5,139,000	7.13
Quadrangles in process of publication (14)	1,830,000	2.54
Additional quadrangles sub- mitted for drafting work prior to publication	1,980,000	2.74

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The drastic curtailment in personnel made necessary by the elimination of CCC as a source of funds has reduced the crews to a skeleton basis. In spite of that, a satisfactory program continues in the office part of the work, and it is expected that within the near future this phase will have caught up with the field mapping procedures.

Aerial Photography in Survey Work

Significant progress was made during 1939 in the adaptation of aerial photography to the requirements of the Forest Survey. Opportunity for study was afforded by a cooperative project with the Soil Conservation Service in the inventory of pine timber on their project area at Placerville. It was necessary to study the classification of types and stand conditions of 30 square miles of territory. In this survey simple and convenient means of determining age-class composition and stand distribution from aerial photography were developed, and simple methods were evolved for representing them on the maps produced by studying the photographs under the stereoscope. Various comparatively easy and accurate methods were developed for the recognition of cover elements and the classification of areas and cover according to rather well-broken down subdivisions.

Survey Reports of Areas

In addition to the publication of the current vegetation type maps, the division has decided to prepare a series of reports to be released from time to time, covering single counties or groups of counties in which various work of the vegetation type map phases of the survey has been completed. Such reports will be valuable additions to the maps themselves. They will present acreages of all vegetation types and timber classification that were included in the original mapping, broken down into important land subdivisions wherever possible. Tables, maps, and designs will supply factual data that are basic to the formulation of many policies and plans dealing with land management and use. The first of these reports has been prepared for the Santa Cruz mountain range.

New Base Maps

Since it is probable that at least two and one-half million acres will be mapped in this region during 1939, especially in the Tahoe National Forest and vicinity, an unusual opportunity will be afforded for preparing new high-quality base maps and for applying on a large scale the new techniques developed in the Placerville survey.

Forest Resource Maps

The forest resource maps, supplementing the vegetation type maps, are essential for forest management and are prepared to the following extent:

Office work completed	8.76
Field work completed	13.87

Inventory

In the field of timber volume inventory, the experimental line plot survey of 468,000 acres on the Bidwell Bar quadrangle was completed during 1936 and 1937. These data will be analyzed during 1939 as a basis for determining intensity of sampling. A plan will then be prepared for the timber volume and growth phase of the survey for California.

Land Use Studies

The land-use studies for the Division are a part of the cooperative study in which Survey and Economics are jointly cooperating with the Giannini Foundation. The project covers land use in the northern Sierra Nevada foothills.

Ecological Studies

The ecological studies growing out of the various phases of vegetation type mapping are designed to put together in usable form the vast reservoir of material on plant distributions and successions procured by the vegetation survey, which cannot be shown on the project's vegetation type maps.

The correlation of the distribution of various species and types with climate, soil, and the effect of fire and other land abuse is yielding information of fundamental value in land-use planning and all other phases of management in which vegetation plays an important part.

FOREST ECONOMICS

Introduction

The primary responsibility of the Division of Forest Economics is the study of the relationship existing between the management of forests and range lands and the economic life of the region. This broad field of activity obviously necessitates the choice of certain restricted fields within which a limiting force can render service. The principal field of activity for some time has been the land-utilization studies in the northern Sierra Nevada foothills, conducted in cooperation with the Giannini Foundation. It was decided by those in charge of the direction of the project to publish a preliminary study of as much as possible of the data already obtained, in a form corresponding to an atlas. This involves the presentation of available data in coordinate text and maps designed to present facts that will show the existing conditions and afford a guide for the development of a consecutive program by action agencies.

It has been necessary to develop new techniques for the delineation of basic land units into which an area shall be broken down as a basis for the construction of an economic classification. The results of this technical study have been embodied in a paper by Professor D. Weeks and H. R. Josephson on "Criteria for economic land use classification". This has been published in the Journal of Farm Economics.

Additional data supplied by the AAA have made possible a more intensive study of the economics of the livestock industry and the evaluation of range-carrying capacity. A major contribution in this field has been the new classification of brushlands with respect to their significance in affecting feed resources.

It is expected to complete this project during 1939.

Currently a second study of importance is being conducted by this division in growth and returns from timber production in the northern Sierra Nevada foothills. This study has centered about an analysis of utilization practices in the second-growth pine belt of the foothills.

FOREST AND RANGE INFLUENCES

Introduction

The problems of the relationship of forest lands to streamflow and water supply in the lowlands are paramount in California. From the chaparral forests in southern California through the pine lands of the Sierra and including the foothill counties, those things that happen in the mountains are seriously reflected in flood or water scarcity in the agricultural lowlands. The philosophy of this division is twofold (1) to find the true factors in the relationships of forest cover to run-off, percolation and streamflow and (2) to develop techniques of management whereby man can modify forest cover in a predetermined direction in order that the flow of usable water may be increased at the proper time. There is still an enormous hiatus in the basic knowledge necessary for the achieving of these two ends. Foresters and engineers are in disagreement as to the true weight to be attached to factors of forest cover. The existence of disagreement itself is sufficient warrant for the execution of an intensive program in watershed research.

The 1938 Flood in Southern California

It was indicated briefly in the introduction that flood and fire had greatly affected the current program in this Division. These two major disasters to installations vital to the proper conduct of research necessitated diversion of a great deal of effort from active research to a rehabilitation program.

In spite of the extraordinary load thereby placed upon technical personnel, by almost superhuman efforts under terrific pressure the staff was able to obtain very valuable records throughout the year. Especially was this true during the storm that occurred between February 27 and March 4, a period of stress without parallel. Although a similar flood in 1883 is reported to have been as large, no measurements are available for comparison.

During the period of 5 days about 19 inches of rain fell upon the San Dimas Experimental Forest. A maximum of nearly 24 inches was recorded in the small watersheds at the head of Fern Canyon. Intensities of three-quarters of an inch per hour during 12-hour periods were typical. All 10 intermediate gaging stations were overtopped by peak run-off rates of from 350 to 450 cubic feet per second per square mile. Complete records were obtained from small watersheds Fern No. 2 and No. 3.

Very large erosion rates, due principally to excessive channel

scour, undercutting of banks, and many large land slumps, caused an amount of material beyond the capacity of debris basins to handle. Complete measurements were obtained from Fern No. 3 watershed with vegetation more than 50 years old and from Bell watershed No. 4 with cover but 19 years old since it was disturbed by fire. The former yielded debris at the rate of 1900 and the latter 18,900 cubic yards per square mile. A special report covering all aspects of this flood as it affected the Experimental Forest was prepared by the San Dimas staff.

Complete precipitation measurements for the year showed the high average of 43.54 inches over the entire forest. Considerable improvement was effected in raingage technique, especially as relates to the elevation and design of gages.

Streamflow data for the year were accurately measured on only Fern watersheds No. 2 and No. 3. On all other watersheds where gaging stations were overtopped, only fairly accurate estimates are available. A comparison between previous records and 1938 records is given by run-off records from Fern watersheds No. 2 and No. 3. From watershed No. 2 the run-off for the March storm was equivalent to 41 percent of the rainfall representing 30 acre feet; from Fern No. 3 the run-off was 18 percent, as compared with 6.6 and 2.2 acre feet respectively for the entire 1936 and 1937 season. Complete data on erosion rates, run-off, and rainfall are available in tabulated form too long for inclusion in this report.

Revision of Plans Due to Fire

The second event of major importance to the San Dimas Experimental Forest took place on November 18, when approximately 500 acres of the oldest and heaviest vegetation, including the Fern small watersheds, were consumed by a fire originating in the San Antonio Canyon. This area had not been burned over in at least 50 years, and it included some of the best oak-chaparral cover in this region. A great deal of research equipment was destroyed by the fire, and plans for future research on these watersheds must be completely revised. The present availability of three or four years' records on precipitation, run-off, and erosion will facilitate greatly the obtaining of comparative records from the burned area. Different treatments are proposed for the three small canyons already under control and for the main Fern watershed. Considerable revision of existing installations will be necessary to care for anticipated increased erosion and run-off rates.

Run-off plots in Fern Canyon were drastically affected by the forest fire. They lay directly in the path of the flames and were subjected to a most intense burn, which cleared the ground and destroyed a great deal of the research installation. What appeared at

first to be a calamity proved to be a ready-made treatment, and moreover a treatment which could never have been produced under controlled conditions. However, had the burn been planned none of the plots would have been denuded this season, and the cover on at least three would have been retained for comparative observations. Fortunately several years' run-off and erosion data are available from the Fern plots. Three of the plots will remain untouched. Three will be treated by cutting the trees and laying the stems across the slope supported by their stumps or supplemental stakes. Three plots were sowed to mustard in the approved manner of treatment of burned areas which has been developed and used on all recent burns in southern California.

Phenological plots in the Fern Canyon country were also burned in the November fire. An opportunity is evident to study plant succession upon plots for comparison with observations made of the 50-year-old vegetation before the fire. Summaries of the vegetation surveys of the run-off plots have been completed for the following periods: Tanbark, series 1935-38; San Dimas, series 1931-38; Fern, series 1935.

The San Dimas Canyon run-off plots are currently maintained.

Consumption of Water by Vegetation - Southern California

The large lysimeter installation at Tanbark Flat was brought near completion, and the research period of calibration was begun. Five additional lysimeters 4 feet wide, 6 feet long, and 6 feet deep, each having one removable end, were installed for the purpose of studying the root development of vegetation which is to be planted in the other lysimeters.

Climatic Records

Complete climatic records for the four main stations were maintained during the year. The Fern Canyon station was badly damaged by the fire but has been rehabilitated, partly by the loans of equipment from other stations.

Geological Relationships

Very interesting progress was made in the study of the geology of the San Dimas Experimental Forest. The map of the Fern Canyon small watersheds shows some interesting relationships between geology, run-off, and erosion. The rocks in Fern Canyon consist largely of metamorphics which strongly resemble thinly-bedded sediments. These pseudo-beds strike at right angles to the line of the stream in Fern No. 3 and dip steeply downstream; in Fern No. 1 the beds strike nearly parallel to the streams and dip roughly parallel to the north-facing slopes;

Fern No. 2 lies about halfway between. This arrangement allows for a maximum of percolation in Fern No. 3 and a minimum in Fern No. 1, and also permits a maximum amount of erosion in Fern No. 1 and a minimum in Fern No. 3. This accords very well with streamflow and erosion measurements taken since the establishment of these stations. The mapping of land slumps in this area has also revealed the fact that eleven of twelve occurred on slopes parallel to the dip of the rock.

The Rehabilitation Task

A surprising amount of excellent technical information was obtained during the year and is available for further analysis. This was all the more surprising in view of the enormous work load of rehabilitation, construction and maintenance. During the year on the average 200 men - WPA, ERA, CCC, and regular employees - were at work on various phases. The size of the job can be well visualized by the following list:

Flood Rehabilitation

- 21 Miles of roads restored.
- 6 Miles of stream channels realigned, cleared of driftwood, and stabilized by retaining walls.
- 10 Miles of raingage trails reconditioned.
- 19 Stream-gaging stations cleaned out and put back in operation.
- 9 Steel San Dimas type flumes installed at the intermediate gaging stations.
- 7 Erosion measurement reservoirs cleared.

Fire Rehabilitation

- Fern run-off and erosion plots repaired and put into operation.
- Portable shelter house set up at Fern dams.
- Temporary telephone connections established.
- Gaging stations protected against excessive peak flows.
- Supplementary masonry sections built for gaging of flows which might be in excess of capacity of flume.

New Work and Regular Maintenance

- 5 Root study lysimeters completed.
- 1 Mile of telephone line constructed.
- 2 Miles of new raingage trail constructed.
- 20 Miles of raingage trail maintained.

5 Rain catchment areas equipped with 5000-gallon tanks for storage of water to be used for fires.
1,000 Feet of stream channel in Tanbark Creek stabilized by barriers and retaining walls.
Stream channel and roadways below Bell multiple watershed dams lined with concrete.
A 100-man labor camp built at Dry Lake for work in the Fern Canyon area. This camp was destroyed by fire in November.

The rehabilitation work is not completed, but every effort will be made during 1939 to continue the collection and compilation of the essential research data obtainable from this forest.

Sierra Watershed Study

On the Kings River unit, where studies are currently conducted with a very small personnel, little can be done except maintenance of records from the important foothills area and from the pine-fir unit at Teakettle Creek.

Plots in Second-growth Ponderosa Pine

The important work in second-growth ponderosa pine at Bass Lake, which was established in 1934 with two triplicate sets of 1/40-acre surface run-off and erosion plots, has been carried through the first 4-year period without disturbing the natural vegetation cover. During this calibration period there was no erosion, and surface run-off averaged only slightly more than one percent of the total precipitation. The study of the effects of light burns on run-off and erosion will be continued during the next 4 years.

Plots in San Joaquin Chaparral Woodland

The surface run-off and erosion plots in the chaparral woodland brush type in the San Joaquin foothills at North Fork have yielded results that have been summarized in a comprehensive report soon to appear. Run-off from annually burned plots has averaged 14 percent of the total precipitation, with erosion rates of over 113 tons per acre. There has been practically no erosion from unburned plots, and the run-off has been negligible. During the next 5 years periodical burning will be discontinued, and the long-time effects will be studied on the voluntary vegetation that will reappear on the area.

Effect of Litter on Run-off and Erosion

The Berkeley studies conducted on the effects of litter depth on surficial run-off and erosion have shown that, as compared to bare soil, 1/4 inch of litter (Monterey pine) effects an average reduction in surface run-off and erosion of from 60 to 80 percent, a reduction in evaporation of from 30 to 40 percent, and an increase in percolation of from 80 to 100 percent. The effect continues to increase at litter depths up to 3/4 inch. Beyond that point changes are only slight.

Consumption of Water by Vegetation

Current studies in the consumption of water by certain chaparral species at Berkeley are continuing with interesting results. Water loss by interception and evaporation or utilization by the plants in transpiration during the 1937-38 season averaged about 54 percent of the precipitation on the Ceanothus series and about 45 percent of the precipitation on the oak series.

At North Fork a study has been conducted since 1934 on moisture content of soils undisturbed, annually burned, and completely denuded. The results thus far show that the higher interception and transpiration rates on the undisturbed areas just about compensate for higher evaporation rates for the soil of annually burned areas.

Flume Studies

Further progress was made during 1938 on experimental investigations of model flumes. One hundred and forty experimental runs using clear water with the one-half scale model of the one-foot prototype were made, involving the following variables:

1. Pressure measurement by means of slot instead of piezometer.
2. Influence of flume length on pressure distribution with standard piezometer points.

A report on these phases of the investigation is in final stages of preparation. The next step in this study will be to determine the effects of various quantities of bed-load and suspended material upon the rating curve for this type of flume.

FLOOD CONTROL SURVEYS

Flood control surveys in this region will continue under the Joint Coordinating Committees Nos. 18 and 20, representing the Forest Service, the Soil Conservation Service, and the Bureau of Agricultural Economics. In addition the State has organized a flood control committee, which cooperates with the Department through the State Engineer and specialists of the University of California.

During the past year 16 public hearings, involving 34 streams, were held in cooperation with the U. S. Engineer Office. Two reports of preliminary examinations on the Kings and Ventura Rivers were submitted to Washington. Reports on the Kern, Kaweah, Tule group, the Pajaro, the Santa Maria, and the Salinas Rivers are ready for submission. It is anticipated that all preliminary survey reports on basins for which hearings have been held will be completed by the end of the year.

As a result of the March flood, authority for final surveys for the Los Angeles, the San Gabriel, and the Santa Ana Rivers was immediately obtained. A sample survey was made of the Arroyo Seco tributary to the Los Angeles River to determine measures necessary to prevent and control abnormal erosion and to retard flood run-off in the interest of flood control and water conservation. The Arroyo Seco report has been completed and submitted to Washington.

The current status of detailed surveys on other watersheds in this area is as follows:

	<u>Percentage completed</u>
Santa Anita	95
San Fernando Valley	75
Dalton Canyon	85
San Jose Creek	90
San Dimas Canyon	10
Mill Creek	75
Cajon Canyon	80

After completion of field work on the above watersheds it is expected that the final survey of the entire Los Angeles River watershed will be completed.

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COOPERATING AGENCIES

BIOLOGICAL SURVEY

The Bureau of Biological Survey is conducting cooperative work with the Forest Service on the relationship of wildlife to various phases of forest and range management.

Forage Consumption by Rodents

During 1938 the Biological Survey was able to station permanently a biologist in residence at the San Joaquin Experimental Range. Additional help, secured through a WPA project brought rapid progress on phases of investigation essential to evaluating the influence of rodents on the range.

Rodent enclosure studies designed to show the quantity of forage eaten and the effect upon plant composition by a definite population of rodents, have yielded very interesting data. It appears that 12 ground squirrels per acre consumed 546 pounds of forage during the year, 16 pocket gophers consumed 478 pounds of forage, and 32 kangaroo rats per acre consumed 937 pounds. The total rodent population, numbers and species unknown, consumed 870 pounds per acre. The normal grazing rate on the plots, for livestock and rodents combined, amounted to 1505 pounds per acre. Total forage production was 2401 pounds.

Pounds of forage per individual rodent of each species may be applicable only when the rodent population is at the density of the experiment. It will be determined later what amount is eaten or destroyed per acre in varying densities of population. Extraordinarily fine data were obtained during the year on seasonal changes in food preference by ground squirrels. They show the most astonishing variability in their food habits throughout the season according to condition of vegetation, distribution, and availability. Similar studies are also being carried out on kangaroo rats, pocket gophers, pack rats, and cottontails.

Food Habits of Rattlesnakes

Studies are also being carried forward on the food habits of rattlesnakes. One hundred and eighteen snakes were captured during the season and the disgorged food analyzed. The food items included young cottontails, ground squirrels, mice, kangaroo rats, pocket gophers, in about that order of importance.

Rodent Census on Foothill Range

To properly evaluate rodent influence on the range and interpret the data secured from enclosures, it is necessary to know the numbers of each species on the range and their fluctuations, through trapping studies and marking of animals. For future use, methods of census have been developed and are affording means for the taking of a census on large portions of the range. Thus far it is known that the squirrel population is less than two years ago, while kangaroo rats are slowly increasing. The rattlesnake population on the small pasture on which a census was taken was one snake per three acres. This pasture is not an optimum snake habitat.

Coyote-deer study

A study in the relationship between coyotes and deer was initiated in 1937 in cooperation with the Regional Office and this Station. The Region plans to make the Mono area on the Los Padres National Forest an experimental game management unit. It appears to be typical of a large portion of southern California deer range. Basic studies have been carried through on the food habits of coyotes. They indicate clearly that these predators are levying toll on the fawns and younger age classes of deer. Work is also in progress on the relationship between coyotes and rodent populations. These data are essential in determining the total function of predation as it applies to deer in this locality and to further add to a particular understanding of the effects of predation in a biotic community.

Trapping of coyotes and bobcats followed by stomach analysis is yielding current information on coyote concentration movements, rates of migration, food habits, the cost of control, and the degree of control required.

Wildlife Related to Pine Regeneration

Further progress has been made on the relationships existing between wildlife and pine regeneration. During the past year several trials of stratified pine seed and repellents applied to pine seed have been made. Anything that would shorten the time between planting and germination of pine seed would limit the period during which it is exposed to rodent attack and increase the possibility of germination and establishment. The results of the stratified trials are as yet incomplete. Thus far, no active deterrents have been found.

Studies of clipping of seedlings by rabbits all show clearly that rabbit damage is far heavier in stripped green brush areas than on stripped burned areas. Clipping damage is somewhat heavier as the burned area returns to green brush. Satisfactory conduct of this project will require a resident biologist in the field. It is anticipated that such a man will be available in the near future.

COOPERATING AGENCIES

BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE

The Berkeley laboratory of the Bureau of Entomology and Plant Quarantine, which cooperates closely with the Experiment Station, is currently conducting important work aimed at the determination of the basic biological factors concerned in forest insect infestations in this region, the effect of insect-caused losses upon the growth and utilization of forest trees, and the development of methods which will insure a measure of forest production without undue insect-caused losses.

This work is of particular importance in connection with the general problem of management in ponderosa pine stands throughout the Sierra, and especially dominant on eastside lands.

One of the major factors of the program at Blacks Mountain Experimental Forest is the development of procedures designed to reduce mortality losses due to insects to as low a degree as possible by effective cutting procedures. There has developed during the past few years a definite belief that it may be possible to forecast the death of individual trees. Steps in the development of this belief were as follows:

It was discovered that successive broods of flathead beetles initiated attacks in a large proportion of the trees that die on the eastside lands. Incipient flathead broods occur in green living trees, often for a considerable period of time before death. Practically all living trees containing heavy incipient broods showed signs of deterioration, although it has not yet been determined whether flathead beetles cause or are mainly associated with causes of decadence. The results show clearly that decadent trees are poor risks.

During 1937 a risk classification was developed. During 1938 an analysis was made of 929 green trees that had been removed in the sanitation cut at Blacks Mountain. One thousand six hundred and two green trees were analyzed during the two periods. The incidence of incipient flathead infestation in each risk class is as follows:

	<u>Percent</u>
Risk 1	6
Risk 2	25
Risk 3	58
Risk 4	87

Of 120 trees located on plots on the Modoc and Lassen National Forests, that died during the period, 103, or 90 percent of the infested volume were in the two high risk classes (3 and 4). Flathead borers had successfully initiated attacks in 30 percent of the samples.

Currently considerable work is being done on the check of external characteristics in order to develop further practical means for the identification of high risk trees in the natural stands.

The Bureau is also conducting an investigation of forest insect hazard to pine stands to develop a basis for consideration of entomological factors concerned in management for the eastside pine region. The Blacks Mountain Experimental Forest was classified by areas as having five degrees of insect infestation in 1937. The present sanitation cut is directly pointed to the reduction of hazard in the most threatened areas. The program when completed will provide an adequate test of the effect of removal of susceptible trees upon the general insect hazards within the forest.

Classification of the entire eastside pine area is being pushed rapidly: 800,000 acres were worked in 1938. It is expected this will be completed in 1941.

During 1938 it was found that various insect infestations, such as the resin midge and red spider, were developing at the Institute of Forest Genetics. The Bureau of Entomology and Plant Quarantine is currently engaged in test spray applications to determine foliage tolerance as a step towards developing spray formulae. It is also engaged in the collection of basic biological information necessary to determine the relative importance of insect damage to young conifers grown under nursery and arboretum conditions.

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